MATERIALS FOR INDIVIDUAL CHEMICAL/BIOLOGICAL PROTECTION

Dr. Eugene Wilusz
Chemical Technology Team
Natick Soldier Center
U.S. Army Soldier and Biological Chemical Command

ATTN: AMSSB-RIP-C(N)
Natick, MA 01760
COM: (508) 233-5486
FAX: (508) 233-4994
EMAIL: ewilusz@natick-emh2.army.mil

APBI - 23 Jun 99

OUTLINE

- Objectives/Technical Challenges
- Material Concepts
- Performance Goals
- Closure Systems
- Indicators/Sensors
- Plans
- Summary

OBJECTIVES/TECHNICAL CHALLENGES

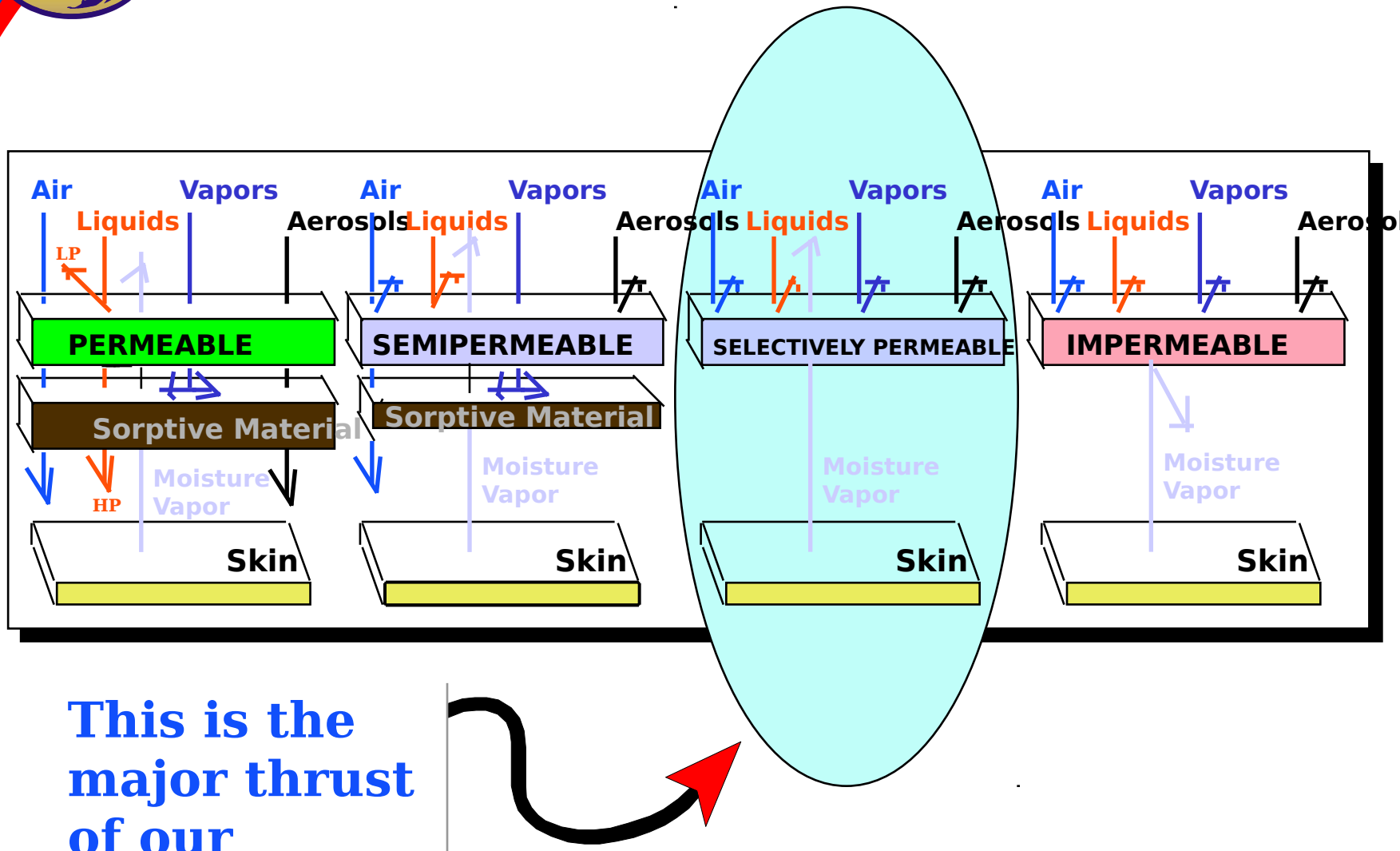
- **Develop CB protective materials that:**

  - Protect against CB warfare agents in liquid, vapor, and aerosol forms
  - Are waterproof and have high evaporative cooling potentials
  - Are flexible, durable, thin, lightweight, low-noise,
- **low-cost,**
  and launderable

- **Develop advanced techniques for characterization of membrane barrier/transport properties**

Develop a lightweight CB protective duty uniform that will be more durable, 30% lighter in weight, and less bulky than the JSLIST duty uniform and overgarment

TYPES OF MATERIALS

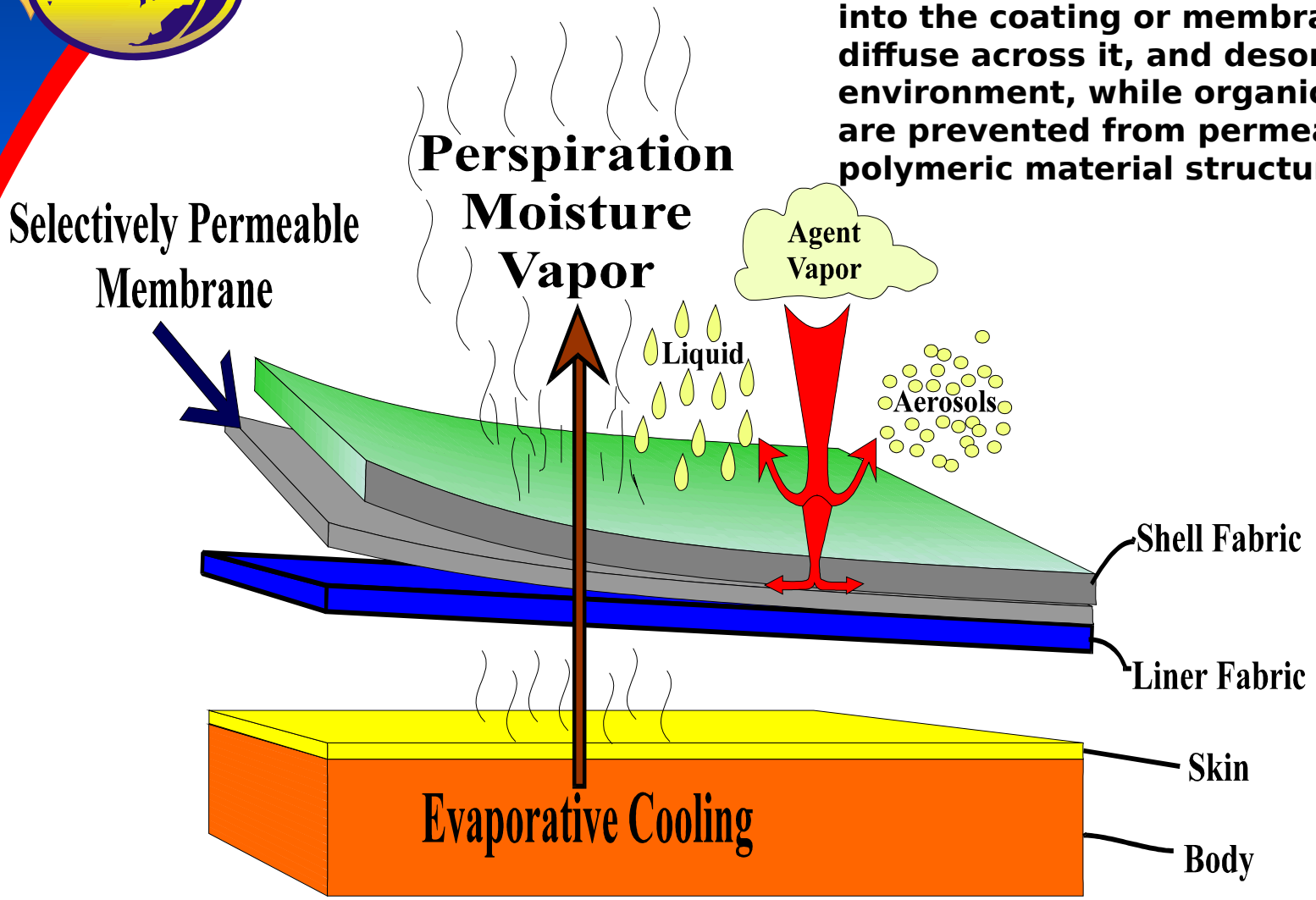


This is the major thrust of our program.

LP: Low Hydrostatic Pressure
HP: High Hydrostatic Pressure

MATERIAL CONCEPT

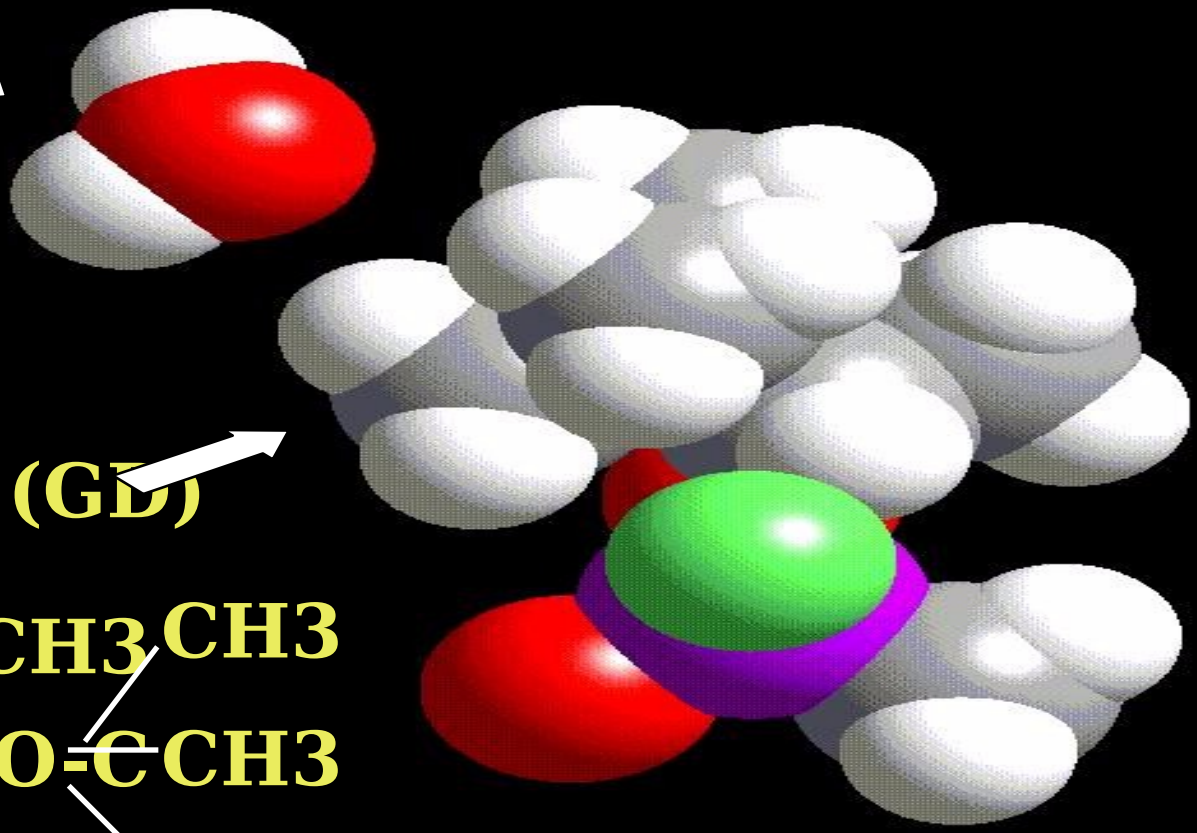
Water vapor molecules selectively diss
into the coating or membrane material
diffuse across it, and desorb into the
environment, while organic vapor mole
are prevented from permeating throug
polymeric material structure.

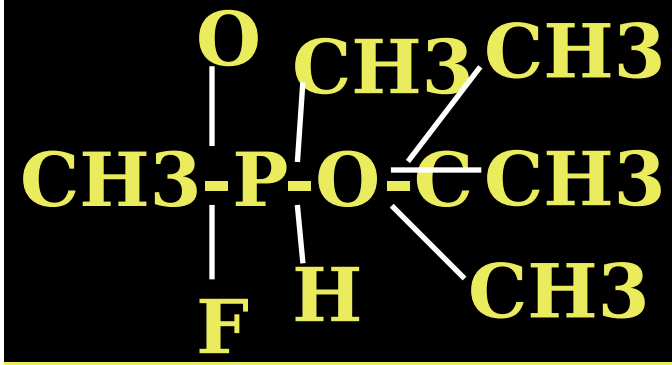


Relative Size of Water and Soman Chemical Warfare Agent Molecules

Water (H_2O)

Soman (GD)





Molecular Weights of Water and Chemical Agents

Molecules	MW (g/mol)	Molecules	MW (g/mol)
Water (H_2O)	18	Blister Agents (Skin):	
		Mustard (HD)	159
Nerve Agents (Nervous Systems):		Nitrogen Mustard (HN-1)	170
Soman (GD)	182	Nitrogen Mustard (HN-2)	93
Sarin (GB)	140	Nitrogen Mustard (HN-3)	205
Tabun (GA)	162	Phosgene Oxime (CX)	123
CMPF (GF)	180	Lewisite (L)	208
VX	267	Phenyldichloroarsine (PD)	224
VE	239	Ethyldichloroarsine (ED)	175
		Methyldichloroarsines (MD)	161
Choking Agents (Respiratory):			
Phosgene (CG)	99	Stemulators (Nose & Throat)	
DiPhosgene	198	Diphenylchloroarsine (DA)	267
		Adamsite (DM)	282

PERFORMANCE GOALS

Chemical Agent Protection: Blister agents (HD), Nerve agents (GB,GD, VX)

Biological Agent Protection: ALL Bacteria and viruses (size: 10 to 10^{-3} μm)

Water Vapor Flux @ 32°C ≥ 1800 g.m^{-2}/24 h)
[or Intrinsic Water Vapor Resistance ≤ 300 s/m*]

Hydrostatic Resistance ≥ 35 lb/in²

Bonding Strength ≥ 10 lb/in²

Stiffness ≤ 0.01 lb

Weight ≤ 7 oz/yd²

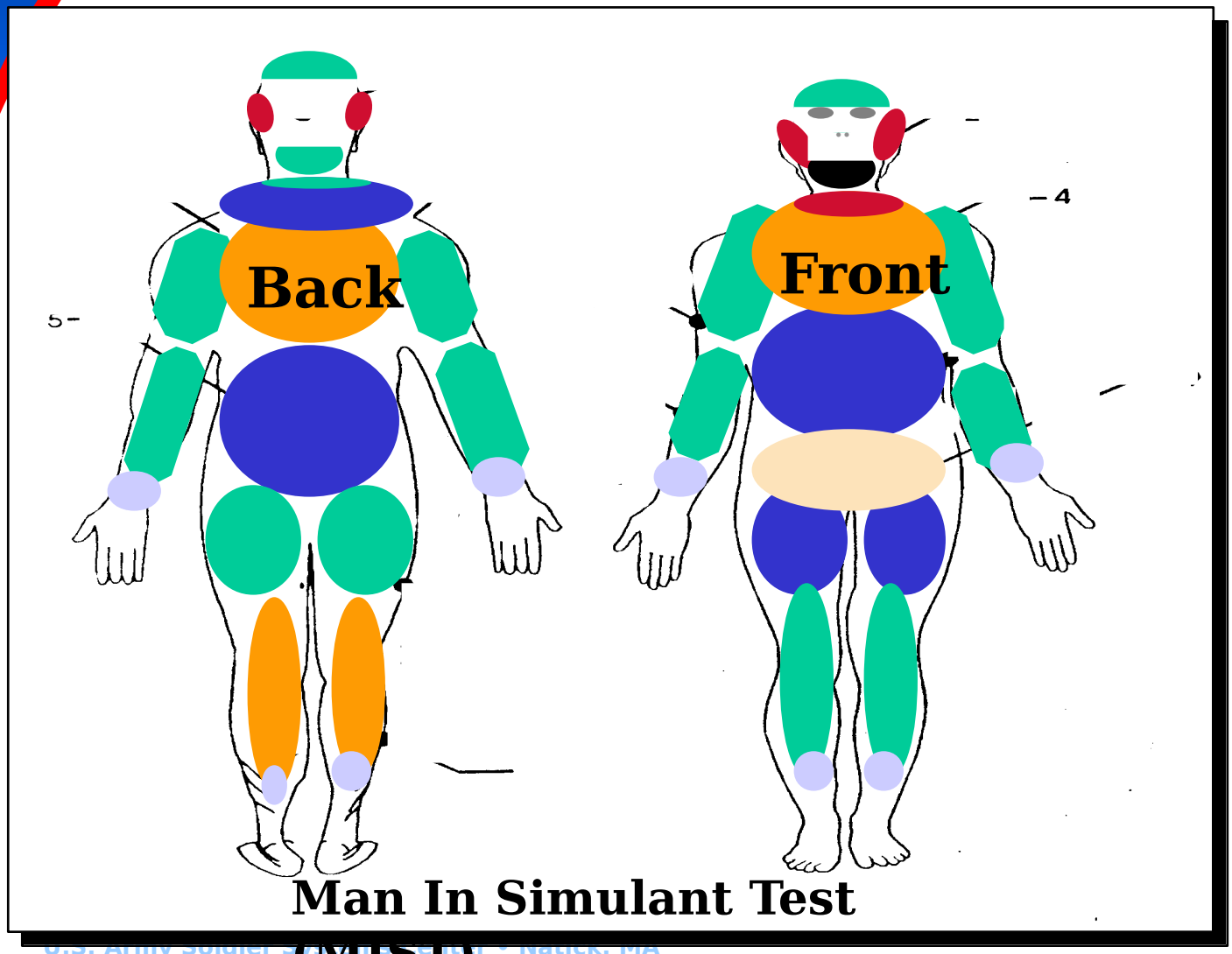
Thickness ≤ 18 mils

Torsional Flexibility: Pass

Water Permeability after flexing at 70 °F and -25 °F: Pass

*Natick Dynamic Moisture Vapor Permeation Cell.

A Closure System is Required



Relative Vapor Penetration on Uniforms:

- A Lowest
- B
- C
- D
- E
- F
- G Highest

Residual Life Indicator

Technology Search - FY99

- **o Organic vapor sensors**
- **o Chemiresistor sensors**
- **o Conductive polymers**
- **o Probe molecules**
- **o pH and chemical devices**
- **o Electron spin resonance**
- **o Dielectric change**
- **o Radiation adsorption**
- **o Spectroscopy**

Downselect and demonstrate - FY00-01

Microclimate Cooling

- **Lightweight , efficient, power sources**
  - **100-150 watts (24 volts DC)**
  - **Current battery pack weighs 11 pounds and pr**
    4 hours of cooling

- **Vapor cycle component development (size and weight**
  - **Compressor**
  - **Heat exchangers (condenser, evaporator)**

- **Alternate technologies**
  - **220-300 watts of cooling**
  - **Weigh less than 7 pounds**

Plans (FY99 - 01)

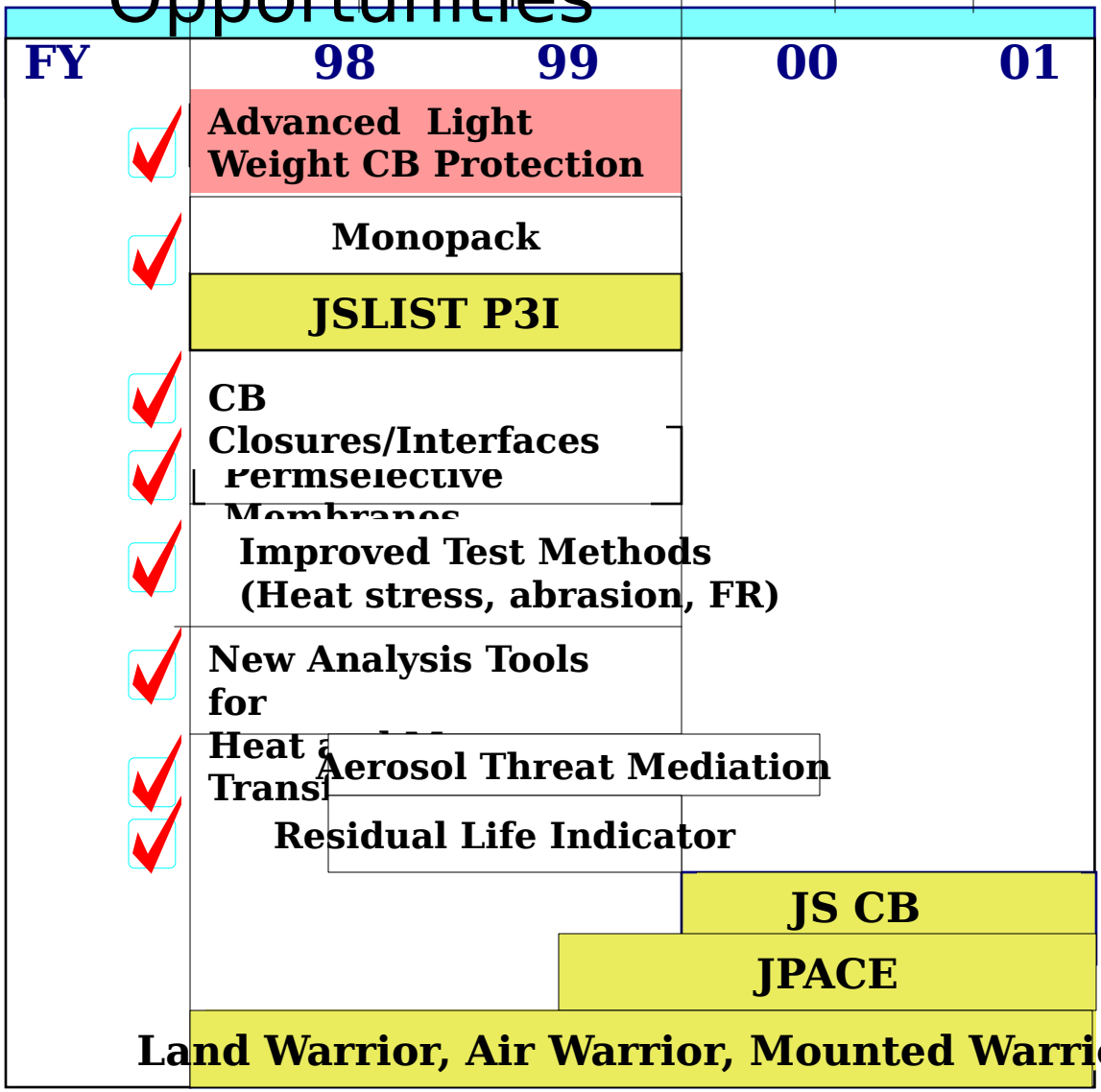
FY99:

- Thermal and water vapor transport properties of fabrics
- Physical properties and live agent testing of fabrics
- Improved closure systems - CB protective clothing integration
- Protection factor (PF) testing of complete prototype ensemble
- Preliminary assessment of ensemble durability and user accep

FY00-01

- Development of a flame resistant, CB protective duty uniform
- System test (MIST) for liquid and semi-volatile aerosol protect
- Garment durability and user acceptability limited field evaluat
- Other applicable technologies
    - o Agent reactive catalysts
    - o Biocides
    - o Microclimate cooling

Industry Participation Opportunities



SUMMARY/CHALLENGE TO INDUSTRY

- **Novel carbon-containing breathable fabrics and non-carbon based CB protective fabric systems have been developed collaboratively by Natick and industry.**
- **Selectively permeable fabrics have excellent dual use in CB/environmental protective clothing for emergency responders, pesticide and industrial chemical handlers, medical personnel, and environmental clean-up personnel.**
- **Collaborative work is sought with industry, academia, and other government agencies especially in development of selectively permeable**